Estimating Color and Grade in Black Cherry and Northern Red Oak Veneer by Electrical Resistance to a Pulsed Current

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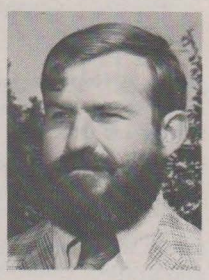

The veneer buyer's objective is to determine accurately, in the field or mill yard, the volume and quality of the veneer in the trees or logs that are being purchased. The buyer may do this by "sounding" a tree for hollows or by looking for broken branches, poorly closed branch stubs, swollen butts, or rotten log ends as indicators of internal defects. Then, using standard grading rules, the buyer predicts volume and quality losses.[1]

The scaling and grading methods are subjective, and their accuracy depends on the user's experience. Although an indicator in standing timber denotes the presence of a defect, its extent depends on many variables such as climate, tree species, and degree of insect infestation.[2] Estimating stain in logs of heartwood-forming species such as oak, cherry, and walnut may be difficult because the stain could be masked by the natural dark color of the heartwood.

A project was conducted by the U.S. Forest Service to determine whether the log buyer could better estimate quality losses in black cherry and northern red oak from readings of electrical resistance of wood to a pulsed current. The readings were used to predict color and grade of veneer in living trees of these species.

Research

The Forest Service, in cooperation with the University of New Hampshire, Durham, studied whether measurements of the electrical resistance of wood to a pulsed current could more accurately detect discoloration and decay in standing timber.[3] The measurements were made with a Shigometer—an electrical resistance meter manufactured by Northeast Electronics Corp., Concord, N.H.[4] The results indicated a strong correlation between electrical resistance and various conditions of wood tissue (sound, discolored, and decayed). A description of the relationship between wounding, microorganisms, and discolored or decayed wood is available.[5,6]

Methods

Forty black cherry (*Prunus serotina Ehrh.*) and 40 northern red oak (*Quercus rubra L.*) of potential veneer quality were selected in the Allegheny National Forest in September, 1975. As the trees were selected, each log in the standing tree was graded as standard or select.

For this project, the term "select" means that on the basis of external indicators (knots, swellings, and branch stubs), there would be insufficient internal defects (color, pin knots, mineral stain, and gum spots) to reduce the quality of the veneer from panel grade (veneer grades 18, 16, and 12 to be used for high-quality paneling and furniture) to furniture grade (veneer grades 14, 10, and 08 to be used for low-quality paneling and furniture). The term "standard" means that there *would* be a reduction in grade.

After the logs had been graded, readings of electrical resistance were taken with a Model 7250 Shigometer. The readings were taken 6″ above the ground (stump height) at one point in the butt log of the standing tree. This was done to eliminate damage to the veneer by the drill hole. At each point,

[1]Rast, Everett D., David L. Sonderman, and Glenn Gammon. "A Guide to Hardwood Log Grading (revised)." USDA For. Serv. Gen. Tech. Rep. NE-1, 1973, 32 pp., illus.

[2]Hepting, George H., and Alex L. Shigo. "Differences in Decay Rate Following Fire Between Oaks in North Carolina and Maine." Plant Dis. Rep. 56(5):406-407.

[3]Shigo, Alex L., and Alex Shigo. "Detection of Discoloration and Decay in Living Trees and Utility Poles." USDA For. Serv. Res. Pap. NE-294, 1974.

Figure 1. The Shigometer is used to detect discoloration and decay in northern red oak.

[4]The use of trade, firm, or corporation names in this article is for the information and convenience of the reader. Such use does not constitute an official endorsement or approval by the U.S. Department of Agriculture or the Forest Service of any product or service to the exclusion of others that may be suitable.

[5]Tattar, Terry A., Alex L. Shigo, and Thomas Chase. "Relationship Between Degree of Resistance to a Pulsed Electric Current and Wood in Progressive Stages of Discoloration and Decay in Living Trees." Can. J. For. Res. 2(3): 236-243, 1972.

[6]Shigo, Alex L. "Succession of Organisms in Discoloration and Decay of Wood." Int. Rev. For. Res., Vol. 2, 1967.

a 3/32″ hole was drilled (radially) in the tree with a Black & Decker cordless electric drill. An electrical probe was inserted into this hole (Figure 1), and readings of electrical resistance were taken serially from the sapwood to the tree center.

To overcome the natural variation in electrical resistance between individual trees, relative resistance values rather than actual resistance readings were used to compare the quality of the wood in these trees. Relative resistance is the value derived by comparing the resistance of the wood at the point of interest with the resistance of the wood at another point known to be of high quality.[7]

The resistance of the wood in question (4″, 6″, etc.) was divided by the resistance in clear sapwood or sound heartwood. (It was assumed that the heartwood at 2″ inside the bark was the best heartwood in the tree because it was the youngest and had been exposed the least to factors causing discoloration.) The value that resulted from this calculation was recorded as the relative resistance of the wood at that particular point. On the basis of the research mentioned previously, wood with a resistance of 0.6 or greater relative to heartwood at 2″, or of 1.9 or greater relative to clear sapwood, was predicted to be panel grade (Figures 2 and 3).

The trees were felled two weeks after being examined with the Shigometer. The end of each cut log was examined and a prediction was made about the effect of stain on the final grade of the veneer. The logs were taken to the mill, sliced into 1/28″ veneer sheets, and graded after drying.

The veneer grader noted the defects (pin knots, gum, mineral, off-centered heart, color) that caused downgrading. The color of the veneer was then noted as excellent, good-excellent, good, fair-good, fair, fair-poor, or poor. Numerical ratings were assigned to each color rating, from 6 for excellent to 0 for poor. Predictions of color and final grade were compared with actual color and grade.

Comparisons were also made between logs and between flitches within each log to determine if one point in the tree could be sampled for an accurate prediction of the quality of the veneer in other portions of that tree.

[7]Shigo, Alex L., Walter C. Shortle, and Julian Ochrymowych. "Detection of Active Decay at Groundline in Utility Poles." USDA For. Serv. Gen. Tech. Rep. NE-35, 1977, 27 pp., illus.

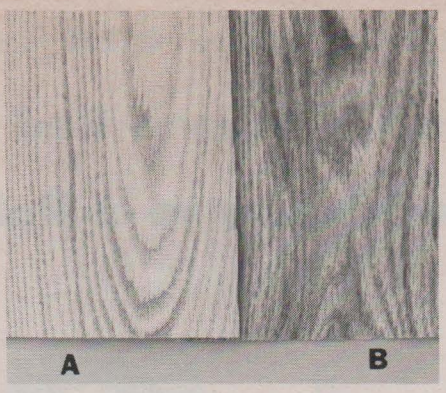

Figure 2. Northern red oak veneer: Excellent-color sample is shown at left, poor-color sample at right.

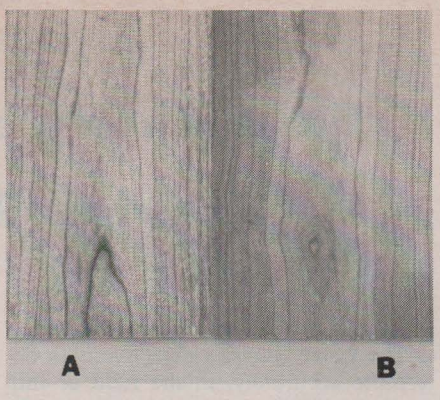

Figure 3. Black cherry veneer: Excellent-color sample is shown at left, poor-color sample at right.

Results

Northern red oak

When heartwood at 2″ from the outside bark was used as a standard for readings of relative resistance, the Shigometer was more accurate in detecting excellent color than were external defects (Table 1). Use of sapwood as a standard reduced the effectiveness of the Shigometer in detecting excellent color. However, use of the sapwood as a standard increased the accuracy of the Shigometer in detecting poor color. The Shigometer and external defects were more helpful than examinations of the end of the cut log for predicting poor color.

Predictions based on examination of the end of the cut logs underestimated the discoloration. Although all the trees that yielded panel-grade veneer were predicted correctly, 83% of those yielding furniture-grade veneer were predicted to yield panel-grade veneer (Table 2).

Color (mineral stain) was a major degrading factor in northern red oak. Mineral stain caused degrade in 52% and color in 28% of the flitches examined. Thus, the strengths and weaknesses of each grading method for detection of color are reflected in predictions of grade distribution (Table 2).

All flitches within a log were given the same color rating in 72% of the logs. In 23% of the logs, only one flitch differed significantly from the remainder of flitches in that log. The second log in the tree was of equal or better quality of color in 88% of the trees examined.

Black cherry

As with the northern red oak, predictions based on examination of the end of the cut log overestimated the color quality. Although 85% of the trees with good color were predicted correctly by this method, only 18% of those with poor color were predicted correctly (Table 3).

Examination of external defects resulted in an underestimation of the number of trees with good color, but the evaluation of external defects was comparable with the Shigometer for detecting trees with poor color. Both methods were more accurate in color determination than was examination of the cut log.

External defects and relative resistance based on sapwood were the most accurate indicators of grade (Table 4).

Color was a degrading factor in only

TABLE 1. Number and percentage of northern red oak trees in which color was predicted correctly using several grading methods

Item	Excellent		Good		Fair-poor	
	No. of trees	% of trees	No. of trees	% of trees	No. of trees	% of trees
Actual color rating	7	—	10	—	18	—
Predicted by Shigometer						
Heartwood	6	86	3	30	14	78
Sapwood	1	14	2	20	17	94
External defects	4	57	2	20	13	72
End of cut log	7	100	10	100	4	22

TABLE 2. Number and percentage of northern red oak trees in which grade distribution was predicted correctly using several grading methods

Item	Panel grade		Furniture grade	
	No. of trees	% of trees	No. of trees	% of trees
Actual grade	17	—	18	—
Predicted by Shigometer				
Heartwood	10	63	14	78
Sapwood	2	13	15	83
External defects	6	38	13	72
End of cut log	17	100	3	17

TABLE 3. Number and percentage of black cherry trees in which color was predicted correctly using several grading methods

Item	Excellent		Good		Fair-poor	
	No. of trees	% of trees	No. of trees	% of trees	No. of trees	% of trees
Actual color rating	7	—	13	—	11	—
Predicted by Shigometer						
Heartwood	7	100	12	92	6	55
Sapwood	3	43	11	85	3	27
External defects	2	29	7	54	7	64
End of cut log	7	100	11	85	2	18

TABLE 4. Number and percentage of black cherry trees in which grade distribution was predicted correctly using several grading methods

Item	Panel grade		Furniture grade	
	No. of trees	% of trees	No. of trees	% of trees
Actual grade	20	—	11	—
Predicted by Shigometer				
Heartwood	7	35	5	45
Sapwood	4	20	9	82
External defects	5	25	11	100
End of cut log	8	40	3	27

5% of the flitches graded. Gum spots affected grade in 64% of the flitches and pin knots in 57%. In 70% of the logs examined, color was comparable in all flitches within the log. In 18% of the logs, one flitch was significantly different from the others in that log. The second log in the tree was of equal or better quality of color in 63% of the trees examined.

Discussion

Electrical resistance is effective in determining color in veneer. Using sapwood as a standard determining relative resistance seemed a more sensitive test than using heartwood as a standard; that is, trees that were considered clear by the heartwood standard were considered discolored by the sapwood standard and vice versa. From the standpoint of current black cherry and red oak color standards, some color change is accepted by the public. Therefore, the heartwood standard seems more accurate for determining color.

Factors other than color (pin knots and gum) are major causes of downgrading in black cherry. These factors, because of their size and scattered patterns, are extremely difficult to detect by electrical resistance. In this case and similar cases, external indicators seem more effective than electrical resistance in predicting grade. These same factors also may be difficult to see in the end of the cut log. Masking of discoloration by the normal heartwood color further complicates the problem.

The limits for discolored wood could be shifted slightly from those previously mentioned. A resistance reading relative to sapwood of 0.9 or greater for red oak and of 1.7 or greater for black cherry indicated wood with good to excellent color. Relative to heartwood, the resistance readings for good to excellent color were 0.5 for red oak and 0.7 for black cherry. These values could be refined further by more extensive work with each species.

Conclusions

Electrical resistance can assist a grader in estimating color in veneer. However, the following factors should be considered in determining if the use of electrical resistance is warranted:

1. *Experience of the grader.* No instrument can replace experience. The electrical technique would be used to supplement one's experience or to train new personnel. Before this evaluation, the author never graded a tree. All predictions were based on the electrical readings. These predictions were as accurate or more accurate than those made by experienced graders using established grading methods.

2. *Increased accuracy vs. equipment cost.* The electrical resistance meters presently available cost approximately $500. This figure should be compared with the money saved by increased accuracy.

3. *Additional grading time.* In another evaluation conducted by the author (unpublished data), the grading time was increased from 0.7-1.4 minutes to 2.5 minutes per tree. Because this equipment would not be used on each tree, the average increase in grading time would not be this high.

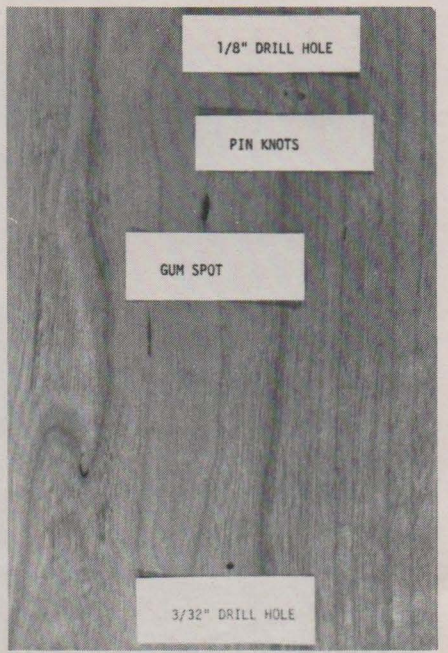

Figure 4. Compare hole sizes made from 3/32" and 1/8" drill bits with natural defects of black cherry.

4. *Importance of color defects.* If other defects such as pin knots and gum predominate, electrical resistance readings could be meaningless.

5. *Species.* Each species has its own characteristics, and the effect of these on the use of electrical resistance must be considered. As with any piece of equipment, the user must work out the methods for each individual situation.

6. *Effects of drilling holes.* A small hole must be drilled into the tree to insert the electrical probe. Figure 4 shows the size of this hole relative to gum spots and pin knots. The hole can be drilled at stump height or in such a place that the hole would be eliminated by the sawyer when he cuts the flitches.

7. *Time of year.* The author had problems taking resistance readings of sugar maple in the spring at the time of heavy sapflow. Also, frozen wood shifted the regression curve, but defective wood could usually be detected.

8. *Extra equipment.* Although the electrical resistance meter is relatively light and compact, it is additional equipment that must be carried into the field.

The field of bioelectronics is relatively new. Its principles are sound, and many technical advances have been made. As is the case with chain saws, air pollution detection equipment, and calculators, an increase in the demand for this technology would probably lead to refinements and equipment miniaturization.

Acknowledgements

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